

density which is lower than the high recording density, the distinguishing information informing that the first region of the information recording substrate has the first thickness T1.

87 (Amended). In combination with a compound objective lens according to any one of claims 133-136, an optical disk, comprising:

an information recording substrate having a thin thickness, the thin thickness of the information recording substrate being thinner than that of a compact disk;

a plurality of first recording pits placed at a first region of the information recording substrate for recording pieces of recording information at a high recording density; and

a plurality of second recording pits placed at a second region of the information recording substrate for recording pieces of distinguishing information at a low recording density, the distinguishing information informing that the first region of the information recording substrate has the thin thickness.

88 (Amended). In combination with a compound objective lens according to any one of claims 133-136, an optical disk apparatus, comprising:

rotating means for rotating an information medium which has a first thickness T1 or a second thickness T2 larger than the first thickness T1;

an optical head apparatus including the compound objective lens for reading an information signal, a focus error signal and a tracking error signal from the information medium rotated by the rotating means through the objective lens;

moving means for moving the optical head apparatus;

connecting means for connecting the rotating means and the moving means with an electric source to supply an electric power to the rotating means and the moving means;

actuating means for actuating the objective lens of the optical head apparatus;

focus control means for controlling the actuating means to perform a first focus control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second focus control of the optical head apparatus corresponding to the second thickness T2 of the information medium according to the focus error signal read by the optical head apparatus;

tracking control means for controlling the actuating means to perform a first tracking control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second tracking control of the optical head apparatus corresponding to the second

19 thickness T2 of the information medium according to the tracking error signal read by the optical  
20 head apparatus;

21 detecting means for detecting whether the information medium has the first thickness T1  
22 or the second thickness T2; and

23 changing means for switching from the second focus and tracking controls performed by  
24 the focus control means and the tracking control means to the first focus and tracking controls  
25 performed by the focus control means and the tracking control means according to the detection  
26 of the detecting means.

1 106 (Amended). A microscope including the compound objective lens having a plurality  
2 of focal points according to any of claims 133-136, further comprising:

3 an ocular lens for receiving a beam of light from a plurality of planes through the lens  
4 and observing the planes, the planes being placed at a plurality of positions different in an optical  
5 axis direction.

1 107 (Amended). A microscope including the compound objective lens having a plurality  
2 of focal points according to any of claims 133-136, further comprising:

3 photographing means for receiving beam of light from a plurality of planes through the  
4 lens and photographing the planes, the planes being placed at a plurality of positions different in  
5 an optical axis direction.

1 108 (Amended). In combination with a compound objective lens according to any of  
2 claims 133-136, an exposing apparatus comprising:

3 an alignment light source for radiating a plurality of beams of alignment light to  
4 illuminate a photomask and a sample placed at different points in an optical axis direction;  
5 said compound objective lens refracting the alignment light generated by the light source  
6 and diverging from the photomask and the sample;

7 light superposing means for superposing the alignment light refracted by the lens to form  
8 a beam of superposed light;

9 ocular lens for converging the superposed light generated by the light superposing means;

10 aligning means for aligning the photomask and the sample according to the superposed  
11 light photographed by the photographing means;

an exposure light for radiating a beam of exposure light; and  
exposing means for exposing a photo sensitive material coated on the sample which is  
aligned with the photomask by the aligning means.

109 (Amended). In combination with a compound objective lens according to any of  
claims 133-136, an exposing apparatus comprising:  
an alignment light source for radiating a plurality of beams of alignment light to  
illuminate a photomask and a sample placed at different points in an optical axis direction;  
said compound objective lens refracting the alignment light generated by the light source  
and diverging from the photomask and the sample;  
light superposing means for superposing the alignment light refracted by the lens to form  
a beam of superposed light;  
photographing means for photographing the superposed light generated by the light  
superposing means;  
aligning means for aligning the photomask and the sample according to the superposed  
light converged by the ocular lens;  
an exposure light source for radiating a beam of exposure light; and  
exposing means for exposing a photo sensitive material coated on the sample which is  
aligned with the photomask by the aligning means to the exposure light radiated from the  
exposure light source.

110. (Amended). In combination with a compound objective lens according to any of  
claims 133-136, an image reproducing apparatus, comprising:  
rotating means for rotating an information medium which has a first thickness T1 or a  
second thickness T2 larger than the first thickness T1;  
an optical head apparatus including the compound objective lens for converging a beam  
of incident light at a plurality of focal points and reading an image information signal, a focus  
error signal and a tracking error signal from the information medium rotated by the rotating  
means;  
moving means for moving the optical head apparatus;  
connecting means for connecting the rotating means and the moving means with an  
electric source to supply an electric power to the rotating means and the moving means;  
actuating means for actuating the compound objective lens of the optical head apparatus;

focus control means for controlling the actuating means to perform a first focus control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second focus control of the optical head apparatus corresponding to the second thickness T2 of the information medium according to the focus error signal read by the optical head apparatus;

tracking control means for controlling the actuating means to perform a first tracking control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second tracking control of the optical head apparatus corresponding to the second thickness T2 of the information medium according to the tracking error signal read by the optical head apparatus; and

displaying means for reproducing the image information signal read by the optical head apparatus as an image.

111 (Amended). In combination with a compound objective lens according to any of claims 133-136, a voice reproducing apparatus, comprising:

rotating means for rotating an information medium which has a first thickness T1 or a second thickness T2 larger than the first thickness T1;

an optical head apparatus including the compound objective lens for converging a beam of incident light at a plurality of focal points and reading a voice information signal, a focus error signal and a tracking error signal from the information medium rotated by the rotating means;

moving means for moving the optical head apparatus;

connecting means for connecting the rotating means and the moving means with an electric source to supply an electric power to the rotating means and the moving means;

actuating means for actuating the compound objective lens of the optical head apparatus;

focus control means for controlling the actuating means to perform a first focus control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second focus control of the optical head apparatus corresponding to the second thickness T2 of the information medium according to the focus error signal read by the optical head apparatus;

tracking control means for controlling the actuating means to perform a first tracking control of the optical head apparatus corresponding to the first thickness T1 of the information medium and a second tracking control of the optical head apparatus corresponding to the second thickness T2 of the information medium according to the tracking error signal read by the optical head apparatus; and

21 voice reproducing means for reproducing the voice information signal read by the optical  
22 head apparatus as voices.

1 112 (Amended). In combination with a compound objective lens according to any of  
2 claims 133-136, an information processing apparatus, comprising:

3 rotating means for rotating an information medium which has a first thickness T1 or a  
4 second thickness T2 larger than the first thickness T1;

5 an optical head apparatus including the compound objective lens for converging a beam  
6 of incident light at a plurality of focal points and reading an information signal, a focus error  
7 signal and a tracking error signal from the information medium rotated by the rotating means;

8 moving means for moving the optical head apparatus;

9 connecting means for connecting the rotating means and the moving means with an  
10 electric source to supply an electric power to the rotating means and the moving means;

11 actuating means for actuating the objective lens of the optical head apparatus;

12 focus control means for controlling the actuating means to perform a first focus control of  
13 the optical head apparatus corresponding to the first thickness T1 of the information medium and  
14 a second focus control of the optical head apparatus corresponding to the second thickness T2 of  
15 the information medium according to the focus error signal read by the optical head apparatus;

16 tracking control means for controlling the actuating means to perform a first tracking  
17 control of the optical head apparatus corresponding to the first thickness T1 of the information  
18 medium and a second tracking control of the optical head apparatus corresponding to the second  
19 thickness T2 of the information medium according to the tracking error signal read by the optical  
20 head apparatus; and

21 information processing means for processing the information signal read by the optical  
22 head apparatus as an image.

1 113 (Amended). In combination with a compound objective lens according to any of  
2 claims 133-136, an optical head apparatus, comprising:

3 a light source for radiating a beam of incident light;

4 a first optical disk having a transparent substrate of a first thickness T1 and an information  
5 recording plane;

6 a second optical disk having a transparent substrate of a second thickness T2 lower than  
7 the first thickness T1 ( $T2 < T1$ ) and an information recording plane;

8        the compound objective lens, partitioned into a plurality of light passing regions  
9        including a first light passing region and a second light passing region respectively  
10       corresponding to a distance from an optical axis of the beam of incident light radiated from the  
11       light source, receiving the beam of incident light radiated from the light source, converging the  
12       beam of incident light, which passes through the second light passing region and the transparent  
13       substrate of the second optical disk, at the information recording plane of the second optical disk,  
14       and converging the beam of incident light, which passes through the first light passing region and  
15       the transparent substrate of the first optical disk, at the information recording plane of the first  
16       optical disk; and

17       a photo detector for detecting the beam of incident light, which is converged at the  
18       information recording plane of the first optical disk and the information recording plane of the  
19       second optical disk by the objective lens and is reflected by the first optical disk and the second  
20       optical disk, to obtain first information recorded in the information recording plane of the first  
21       optical disk and second information recorded in the information recording plane of the second  
22       optical disk.

1        115 (Amended). In combination with a compound objective lens according to any of  
2        claims 133-136, an optical disk apparatus, comprising:

3        a light source for radiating a beam of incident light;

4        a first optical disk having a transparent substrate of a first thickness T1 and an information  
5        recording plane;

6        a second optical disk having a transparent substrate of a second thickness T2 lower than  
7        the first thickness T1 ( $T2 < T1$ ) and an information recording plane;

8        rotating means for rotating the first optical disk or the second optical disk;

9        an optical head apparatus, which comprises

10       the compound objective lens, partitioned into a plurality of light passing regions  
11       including a first light passing region and a second light passing region respectively  
12       corresponding to a distance from an optical axis of the beam of incident light radiated from the  
13       light source, for receiving the beam of incident light radiated from the light source, converging  
14       the beam of incident light, which passes through the second light passing region and the  
15       transparent substrate of the second optical disk, at the information recording plane of the second  
16       optical disk, and converging the beam of incident light, which passes through the first light

passing region and the transparent substrate of the first optical disk, at the information recording plane of the first optical disk; and

a photo detector for detecting the beam of incident light which is converged at the information recording plane of the first optical disk or the information recording plane of the second optical disk by the compound objective lens and is reflected by the first optical disk or the second optical disk;

focus control means for performing a first focus control of the optical head apparatus corresponding to the first thickness T1 of the first optical disk and a second focus control of the optical head apparatus corresponding to the second thickness T2 of the second optical disk according to the beam of incident light detected by the photo detector;

tracking control means for performing a first tracking control of the optical head apparatus corresponding to the first thickness T1 of the first optical disk and a second tracking control of the optical head apparatus corresponding to the second thickness T2 of the second optical disk according to the beam of incident light detected by the photo detector; and

information detecting means for judging according to the beam of incident light detected by the photo detector of the optical head apparatus, for which the first focus control and the second focus control of the focus control means and the first tracking control and the second tracking control of the tracking control means are performed, whether the beam of incident light radiated from the light source is converged at the information recording plane of the first optical disk or the information recording plane of the second optical disk, reproducing first information recorded in the information recording plane of the first optical disk from the beam of incident light detected by the photo detector in cases where it is judged that the beam of incident light radiated from the light source is converged at the information recording plane of the first optical disk, and reproducing second information recorded in the information recording plane of the second optical disk from the beam of incident light detected by the photo detector in cases where it is judged that the beam of incident light radiated from the light source is converged at the information recording plane of the second optical disk, and

moving means for moving the optical head apparatus.

116 (Amended). In combination with a compound objective lens according to any of claims 133-136, an optical head apparatus, comprising:

a laser light source for radiating a beam of incident light;

4        a first information medium having an information recording plane and a transparent  
5        substrate of a first thickness T1, a thickness of the first information medium being set to T1;  
6        a second information medium having an information recording plane and a transparent  
7        substrate of a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), a thickness of the  
8        second information medium being set to T2; and  
9        a light focusing optical system, in which the compound objective lens comprises:  
10       a first lens region, corresponding to a numerical aperture NA1, for focusing the beam of  
11       incident light radiated from the laser light source on the information recording plane of the first  
12       information medium through the transparent substrate of the first information medium as a light  
13       spot for the purpose of reading out first information from the first information medium;  
14       a second lens region, corresponding to a numerical aperture NA2 higher than the  
15       numerical aperture NA1 ( $NA1 < NA2$ ), for focusing the beam of incident light radiated from the  
16       laser light source on the information recording plane of the second information medium through  
17       the transparent substrate of the second information medium as a light spot for the purpose of  
18       reading out second information from the second information medium; and  
19       a third lens region which corresponds to a numerical aperture NA3 satisfying  
20        $NA1 \leq NA3 < NA2$  and is unified with the second lens region of the compound objective lens  
21       through a discontinuous plane.

1        122 (Amended). In combination with a compound objective lens according to any of  
2        claims 133-136, an optical disk apparatus, comprising:  
3        a laser light source for radiating a beam of incident light;  
4        a first information medium having an information recording plane and a transparent  
5        substrate of a first thickness T1, a thickness of the first information medium being set to T1;  
6        a second information medium having an information recording plane and a transparent  
7        substrate of a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), a thickness of the  
8        second information medium being set to T2;  
9        rotating means for rotating the first information medium or the second information  
10       medium;  
11       an optical head apparatus, which comprises  
12       a light focusing optical system, in which the compound objective lens comprises:



13 a first lens region, corresponding to a numerical aperture NA1, for focusing the beam of  
14 incident light radiated from the laser light source on the information recording plane of the first  
15 information medium through the transparent substrate of the first information medium as a light  
16 spot for the purpose of reading out first information from the first information medium;

17 a second lens region, corresponding to a numerical aperture NA2 higher than the  
18 numerical aperture NA1 ( $NA1 < NA2$ ), for focusing the beam of incident light radiated from the  
19 laser light source on the information recording plane of the second information medium through  
20 the transparent substrate of the second information medium as a light spot for the purpose of  
21 reading out second information from the second information medium; and

22 a third lens region which corresponds to a numerical aperture NA3 satisfying  
23  $NA1 \leq NA3 < NA2$  and is unified with the second lens region of the objective lens through a  
24 discontinuous plane;

25 focus control means for performing a first focus control of the optical head apparatus  
26 corresponding to the first thickness T1 of the first information medium and a second focus  
27 control of the optical head apparatus corresponding to the second thickness T2 of the second  
28 information medium according to the beam of incident light detected by the photo detector;

29 tracking control means for performing a first tracking control of the optical head  
30 apparatus corresponding to the first thickness T1 of the first information medium and a second  
31 tracking control of the optical head apparatus corresponding to the second thickness T2 of the  
32 second information medium according to the beam of incident light detected by the photo  
33 detector; and

34 information detecting means for judging according to the beam of incident light detected  
35 by the photo detector of the optical head apparatus, for which the first focus control and the  
36 second focus control of the focus control means and the first tracking control and the second  
37 tracking control of the tracking control means are performed, whether the beam of incident light  
38 radiated from the light source is converged at the information recording plane of the first  
39 information medium or the information recording plane of the second information medium,  
40 reproducing the first information recorded in the information recording plane of the first  
41 information medium from the beam of incident light detected by the photo detector in cases  
42 where it is judged that the beam of incident light radiated from the light source is converged at  
43 the information recording plane of the first information medium, and reproducing the second  
44 information recorded in the information recording plane of the second information medium from

45 the beam of incident light detected by the photo detector in cases where it is judged that the beam  
46 of incident light radiated from the light source is converged at the information recording plane of  
47 the second information medium; and  
48 moving means for moving the optical head apparatus.

1 126 (Amended). In combination with a compound objective lens according to any of  
2 claims 133-136, an optical head apparatus, comprising:

3 a light source for radiating a beam of incident light;

4 a first information medium having an information recording plane and a transparent  
5 substrate of a first thickness T1 a thickness of the first information medium being set to T1;

6 a second information medium having an information recording plane and a transparent  
7 substrate of a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), a thickness of the  
8 second information medium being set to T2;

9 a light focusing optical system for receiving the beam of incident light radiated from the  
10 light source and focusing the beam of incident light on the information recording plane of the  
11 first information medium or the second information medium through the transparent substrate of  
12 the first thickness T1 or the transparent substrate of the second thickness T2 to read out  
13 information recorded in the first information medium or the second information medium, the  
14 light focusing optical system comprising

15 a phase adjusting device, formed in a ring-band shape, for shifting a part of the beam of  
16 incident light radiated from the light source, and

17 wherein the compound objective lens, has a light converging performance so as to  
18 converge the beam of incident light radiated from the light source on the information recording  
19 plane of the second information medium through the transparent substrate of the second  
20 thickness T2 at a diffraction limit, for converging the beam of incident light, of which the part is  
21 shifted by the phase adjusting device, on the information recording plane of the first information  
22 medium or the second information medium through the transparent substrate of the first  
23 thickness T1 or the transparent substrate of the second thickness T2; and

24 a photo detector for detecting the beam of incident light, which is converged on the  
25 information recording plane of the first information medium or the information recording plane  
26 of the second information medium by the light focusing optical system and is reflect by the first  
27 information medium or the second information medium, to reproduce information recorded in  
28 the first information medium or the second information medium.

1        130 (Amended). A compound objective lens according to any of claims 133-136, wherein  
2 the compound objective lens includes:

3        a first lens region, corresponding to a first numerical aperture NA1, for focusing a beam  
4 of incident light, which is radiated from a laser light source and transmits through a transparent  
5 substrate of a first information medium having a first thickness T1, to form a light spot on an  
6 information recording plane of the first information medium for the purpose of reading out  
7 information from the first information medium;

8        a second lens region, corresponding to a second numerical aperture NA2 higher than the  
9 first numerical aperture NA1 ( $NA1 < NA2$ ), for focusing the beam of incident light, which is  
10 radiated from the laser light source and transmits through a transparent substrate of a second  
11 information medium having a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), to  
12 form a light spot on an information recording plane of the second information medium for the  
13 purpose of reading out information from the second information medium; and

14        a third lens region, corresponding to a numerical aperture NA4 equal to or lower than the  
15 numerical aperture NA1 ( $NA4 \leq NA1$ ), for changing the beam of incident light radiated from the  
16 laser light source to converge the beam of incident light on the information recording plane of  
17 the first information medium through the transparent substrate of the first information medium  
18 having the first thickness T1.

1        131 (Amended). In combination with a compound objective lens according to any of  
2 claims 133-136, an optical head apparatus, comprising:

3        a laser light source for radiating a beam of incident light;

4        a first information medium having an information recording plane and a transparent  
5 substrate of a first thickness T1, a thickness of the first information medium being set to T1;

6        a second information medium having an information recording plane and a transparent  
7 substrate of a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), a thickness of the  
8 second information medium being set to T2; and

9        a light focusing optical system, in which the compound objective lens comprises:

10        a first lens region, corresponding to a numerical aperture NA1, for focusing the beam of  
11 incident light radiated from the laser light source on the information recording plane of the first

information medium through the transparent substrate of the first information medium as a light spot for the purpose of reading out first information from the first information medium;

a second lens region, corresponding to a numerical aperture NA2 higher than the numerical aperture NA1 ( $NA1 < NA2$ ), for focusing the beam of incident light radiated from the laser light source on the information recording plane of the second information medium through the transparent substrate of the second information medium as a light spot for the purpose of reading out second information from the second information medium; and

a third lens region, corresponding to a numerical aperture NA4 equal to or lower than the numerical aperture NA1 ( $NA4 \leq NA1$ ), for changing the beam of incident light radiated from the laser light source to converge the beam of incident light on the information recording plane of the first information medium through the transparent substrate of the first information medium having the first thickness T1; and

a photo detector for detecting the beam of incident light, which is converged on the information recording plane of the first information medium or the information recording plane of the second information medium by the light focusing optical system and is reflect by the first information medium or the second information medium, to reproduce the first information recorded in the first information medium or the second information recorded in the second information medium.

132 (Amended). In combination with a compound objective lens according to any of claims 133-136, an optical disk apparatus, comprising:

a laser light source for radiating the beam of incident light having a particular wavelength;

a first information medium, having an information recording plane and a transparent substrate of a first thickness T1, for recording first information on the information recording plane, a thickness of the first information medium being set to T1;

a second information medium, having an information recording plane and a transparent substrate of a second thickness T2 smaller than the first thickness T1 ( $T2 < T1$ ), for recording second information on the information recording plane, a thickness of the second information medium being set to T2;

rotating means for rotating the first information medium or the second information medium;

14 an optical head apparatus, which comprises  
15 a light focusing optical system, in which the compound objective lens comprises:  
16 a first lens region, corresponding to a numerical aperture NA1, for focusing the beam of  
17 incident light radiated from the laser light source on the information recording plane of the first  
18 information medium through the transparent substrate of the first information medium as a light  
19 spot for the purpose of reading out first information from the first information medium;  
20 a second lens region, corresponding to a numerical aperture NA2 higher than the  
21 numerical aperture NA1 ( $NA1 < NA2$ ), for focusing the beam of incident light radiated from the  
22 laser light source on the information recording plane of the second information medium through  
23 the transparent substrate of the second information medium as a light spot for the purpose of  
24 reading out second information from the second information medium; and  
25 a third lens region, corresponding to a numerical aperture NA4 equal to or lower than the  
26 numerical aperture NA1 ( $NA4 \leq NA1$ ), for changing the beam of incident light radiated from the  
27 laser light source to converge the beam of incident light on the information recording plane of  
28 the first information medium through the transparent substrate of the first information medium  
29 having the first thickness T1;  
30 focus control means for performing a first focus control of the optical head apparatus  
31 corresponding to the first thickness T1 of the first information medium and a second focus  
32 control of the optical head apparatus corresponding to the second thickness T2 of the second  
33 information medium according to the beam of incident light detected by the photo detector;  
34 tracking control means for performing a first tracking control of the optical head  
35 apparatus corresponding to the first thickness T1 of the first information medium and a second  
36 tracking control of the optical head apparatus corresponding to the second thickness T2 of the  
37 second information medium according to the beam of incident light detected by the photo  
38 detector; and  
39 information detecting means for judging according to the beam of incident light detected  
40 by the photo detector of the optical head apparatus, for which the first focus control and the  
41 second focus control of the focus control means and the first tracking control and the second  
42 tracking control of the tracking control means are performed, whether the beam of incident light  
43 radiated from the light source is converged at the information recording plane of the first  
44 information medium or the information recording plane of the second information medium,  
45 reproducing the first information recorded in the information recording plane of the first

46 information medium from the beam of incident light detected by the photo detector in cases  
47 where it is judged that the beam of incident light radiated from the light source is converged at  
48 the information recording plane of the first information medium, and reproducing the second  
49 information recorded in the information recording plane of the second information medium from  
50 the beam of incident light detected by the photo detector in cases where it is judged that the beam  
51 of incident light radiated from the light source is converged at the information recording plane of  
52 the second information medium; and  
53 moving means for moving the optical head apparatus.

1 133 (New). A compound objective lens, in which a light beam passes through a  
2 portion of the lens onto an optical disk placed apart from the lens, wherein  
3 the portion of the lens is divided into a plurality of regions including at least a first region and a  
4 second region depending on differences in distance from an optical axis of the light beam,  
5 the first region being optimized so that a light beam passing the first region converges onto an  
6 optical disk of a first thickness T1,  
7 the second region being optimized so that a light beam passing the second region is  
8 converged onto any of the optical disk of the first thickness T1 and an optical disk of a second  
9 thickness T2 larger than the thickness T1 ( $T2 > T1$ ), the second region including a hologram, and  
10 a relationship of  $NA2 < NA1$  being satisfied by locating the first region at a position  
11 farther from the optical axis than a position of the second region, where NA1 and NA2 are  
12 numeral apertures of the lens that permit the light beam to converge onto the optical disk of the  
13 thicknesses T1 and T2, respectively.

1 134 (New). A compound objective lens receiving a beam of incident light, comprising:  
2 a refraction type of lens passing the beam therethrough and providing a refracted light  
3 beam; and  
4 a concentric circle relief type of lens, which is placed to receive either the beam of  
5 incident light or the refracted light beam, for performing phase modulation on the beam received  
6 thereby so as to meet the relationships of  
7  $T1 < T2$  and  $NA1 > NA2$ ,  
8 wherein a numerical aperture required when the beam is converged at a first focal point  
9 after the refraction type of lens, on an optical disk having a thickness of T1 is NA1 and a further  
10 numerical aperture required when the beam is converged at a second focal point, after the  
11 refraction type of lens, on a further optical disk having a thickness of T2 is NA2, respectively.

1        135 (New). A compound objective lens receiving an incident beam light, comprising:  
2        a refraction type of lens adapted to pass the beam therethrough and to provide a refracted  
3        light beam; and  
4        a second lens receiving either the incident light beam or the refracted light beam and  
5        adapted to perform phase modulation on a beam received thereby so as to meet the relationships  
6        of  
7         $T1 < T2$  and  $NA1 > NA2$ ,  
8        wherein a numerical aperture required when the beam received by the second lens is  
9        converged at a first focal point on a first receiving object having a thickness of  $T1$  is  $NA1$  and a  
10       numerical aperture required when the beam received by the second lens is converged at a second  
11       focal point on a further receiving object having a thickness of  $T2$  is  $NA2$ .

1        136 (New). A compound objective lens receiving a beam of incident light, comprising:  
2        a refraction type of lens passing the beam therethrough and providing a refracted light  
3        beam; and  
4        a concentric circle relief type of lens, which is placed to receive either the beam of  
5        incident light or the refracted light beam, for performing phase modulation on the beam received  
6        thereby so as to converge the received light beam at different focal points,  
7        wherein one of the focal points is equal to or higher than 0.6.

137 (New). The compound objective lens according to claim 133, wherein the first  
region includes a further hologram.

138 (New). The compound objective lens according to claim 133, wherein the lens  
includes a region excluding a hologram.

1        139 (New). An optical head apparatus including the compound objective lens  
2        according to any one of claims 133-136 for performing at least one of recording and  
3        reproduction of pieces of information on to and from an optical disk placed to face the optical

4 head apparatus, the optical disk including a first transparent substrate of thickness T1 and a  
5 second transparent substrate of thickness T2, comprising:

6 an optical source for radiating a light beam;

7 wherein the compound objective lens receives the light beam radiated by the optical  
8 source so as to converge the light beam at micro-spots on the first and second substrates of the  
9 optical disk, and wherein the compound objective lens includes

10 a first region optimized so that the light beam passing the first region converges at  
11 the micro-spots on the first substrate of smaller thickness of the optical disk,

12 a second region optimized so that the light beam passing the second region is  
13 converged at the micro-spots on any of the first and second substrates of the optical disk,  
14 the second region including a hologram, and wherein

15 NA1 and NA2 are numeral apertures of the lens that permit the light beam to  
16 converge at the micro-spots on the first and second substrates of the optical disk,  
17 respectively.

1 140 (New) An optical disk apparatus including the compound objective lens  
2 according to any one of claims 133-136, comprising:

3 (a): an optical head apparatus placed to face an optical disk including a first transparent  
4 substrate of thickness T1 and a second transparent substrate of thickness T2, the optical head  
5 apparatus including:

6 (i): an optical source for radiating a light beam;

7 (ii): the compound objective lens receiving the light beam radiated by the optical  
8 source so as to converge the light beam at micro-spots on the first and second substrates  
9 of the optical disk, wherein the compound objective lens includes

10 a first region optimized so that the light beam passing the first region  
11 converges at the micro-spots on the first substrate of smaller thickness of the  
12 optical disk,

13 a second region optimized so that the light beam passing the second region  
14 is converged at the micro-spots on any of the first and second substrates of the  
15 optical disk, the second region including a hologram, and wherein



16 NA1 and NA2 are numeral apertures of the lens that permit the light beam  
17 to converge at the micro-spots on the first and second substrates of the optical  
18 disk, respectively, whereby  $T_2 > T_1$  and  $NA_2 < NA_1$ ;

19 (iii): focus control means for controlling focuses of the optical head apparatus  
20 correspondingly to the thicknesses of the substrates on the basis of the light beam, the  
21 focuses being realized by the convergence of the light beam passing the first and second  
22 regions of the compound objective lens;

23 (iv): tracking control means for performing a tracking control of the optical head  
24 apparatus correspondingly to the thicknesses of the substrates on the basis of the light  
25 beam; and

26 (v): information detecting means for determining whether each of the substrates is  
27 of thickness  $T_1$  or  $T_2$  and detecting pieces of information recorded on each determined  
28 substrate on the basis of the light beam;

29 (b): moving means for moving the optical head apparatus;

30 (c): rotating means for rotating the optical disk; and

31 (d): reproducing means for reproducing the pieces of information detected by the  
32 information detecting means upon a move of the optical head apparatus caused by the moving  
33 means and a rotation of the optical disk caused by the rotating means.

1 141 (New). An optical disk information equipment including the compound objective  
2 lens according to any one of claims 133-136, comprising:

3 (1) an optical disk apparatus, including:

4 (a): an optical head apparatus placed to face an optical disk including a first transparent  
5 substrate of thickness  $T_1$  and a second transparent substrate of thickness  $T_2$ , the optical head  
6 apparatus having:

7 (i): an optical source for radiating a light beam;

8 (ii): the compound objective lens receiving the light beam radiated by the optical  
9 source so as to converge the light beam at micro-spots on the first and second substrates  
10 of the optical disk, wherein the compound objective lens includes

11 a first region optimized so that the light beam passing the first region converges at  
12 the micro-spots on the first substrate of smaller thickness of the optical disk,

13 a second region optimized so that the light beam passing the second region is  
14 converged at the micro-spots on any of the first and second substrates of the optical disk,  
15 the second region including a hologram, and wherein

16 NA1 and NA2 are numeral apertures of the lens that permit the light beam to  
17 converge at the micro-spots on the first and second substrates of the optical disk,  
18 respectively, whereby  $T2 > T1$  and  $NA2 < NA1$ ;

19 (iii): focus control means for controlling focuses of the optical head apparatus  
20 correspondingly to the thicknesses of the substrates on the basis of the light beam, the  
21 focuses being realized by the convergence of the light beam passing the first and second  
22 regions of the compound objective lens;

23 (iv): tracking control means for performing a tracking control of the optical head  
24 apparatus correspondingly to the thicknesses of the substrates on the basis of the light  
25 beam; and

26 (v): information detecting means for determining whether each of the substrates is  
27 of thickness T1 or T2 and detecting pieces of information recorded on each determined  
28 substrate on the basis of the light beam;

29 (b): moving means for moving the optical head apparatus;

30 (c): rotating means for rotating the optical disk; and

31 (d): reproducing means for reproducing the pieces of information detected by the  
32 information detecting means upon a move of the optical head apparatus caused by the moving  
33 means and a rotation of the optical disk caused by the rotating means; and

34 (2) : an image signal generator for generating an image signal based on the reproduced  
35 pieces of information.

1 142 (New). A computer system including the compound objective lens according to any  
2 one of claims 133-136, comprising:

3 (1): optical disk apparatus, comprising:

4        (a): an optical head apparatus placed to face an optical disk including a first transparent  
5        substrate of thickness T1 and a second transparent substrate of thickness T2, the optical head  
6        apparatus including:

7                (i): an optical source for radiating a light beam;

8                (ii): the compound objective lens receiving the light beam radiated by the optical  
9        source so as to converge the light beam at micro-spots on the first and second substrates  
10       of the optical disk, wherein the compound objective lens includes

11               a first region optimized so that the light beam passing the first region converges at  
12       the micro-spots on the first substrate of smaller thickness of the optical disk,

13               a second region optimized so that the light beam passing the second region is  
14       converged at the micro-spots on any of the first and second substrates of the optical disk,  
15       the second region including a hologram, and wherein

16               NA1 and NA2 are numeral apertures of the lens that permit the light beam to  
17       converge at the micro-spots on the first and second substrates of the optical disk,  
18       respectively, whereby  $T2 > T1$  and  $NA2 < NA1$ ;

19               (iii): focus control means for controlling focuses of the optical head apparatus  
20       correspondingly to the thicknesses of the substrates on the basis of the light beam, the  
21       focuses being realized by the convergence of the light beam passing the first and second  
22       regions of the compound objective lens;

23               (iv) tracking control means for performing a tracking control of the optical head  
24       apparatus correspondingly to the thicknesses of the substrates on the basis of the light  
25       beam; and

26               (v) information detecting means for determining whether each of the substrates is  
27       of thickness T1 or T2 and detecting pieces of information recorded on each determined  
28       substrate on the basis of the light beam;

29       (b): moving means for moving the optical head apparatus;

30       (c): rotating means for rotating the optical disk; and

31       (d): reproducing means for reproducing the pieces of information detected by the  
32       information detecting means upon a move of the optical head apparatus caused by the moving  
33       means and a rotation of the optical disk caused by the rotating means;

34        (2): a signal inputting unit for inputting pieces of information to be recorded on the  
35        substrates;

36        (3): a central processing unit for processing the pieces of information recorded on the  
37        substrates and processing the pieces of information to be recorded on the substrates; and

38        (4): a signal outputting unit for outputting the pieces of information recorded on the  
39        substrates.

1        143 (New). The compound objective lens according to any one of claims 133-136,  
2        configured for converging an incident light beam onto an optical disk including a first optical  
3        disk of thickness T1 and a second optical disk of thickness T2, comprising:

4        a numerical aperture changer for satisfying the relationship  $NA2 < NA1$ , in which NA2 is  
5        a numeral aperture of the second region to make the light beam converge onto the second optical  
6        disk and NA1 is a numeral aperture of a region comprising the first region and the second region  
7        to make the light beam converge onto the first optical disk.

1        144 (New). An optical head apparatus including the compound objective lens according  
2        to any one of claims 133-136 for performing at least one of recording and reproduction of pieces  
3        of information on to and from an optical disk placed to face the optical head apparatus, the  
4        optical disk including a first transparent substrate of thickness T1 and a second transparent  
5        substrate of thickness T2, the optical head apparatus comprising:

6        an optical source for radiating a light beam; and  
7        the compound objective lens receiving the light beam radiated by the optical source so as  
8        to converge the light beam at micro-spots on the first and second substrates of the optical disk;  
9        and including first and second regions passing the light beam so that a numerical aperture  
10       changer satisfies the relationship  $NA2 < NA1$ , in which NA2 is a numeral aperture of the second  
11       region to make the light beam converge onto the second optical disk and NA1 is a numeral  
12       aperture of a region comprising the first region and the second region to make the light beam  
13       converge onto the first optical disk.

1        145 (New). An optical disk apparatus including the compound objective lens according to  
2 any one of claims 133-136, comprising:

3        (a): an optical head apparatus placed to face an optical disk including a first transparent  
4 substrate of thickness T1 and a second transparent substrate of thickness T2, the optical head  
5 apparatus comprising:

6                (i): an optical source for radiating a light beam;

7                (ii): the compound objective lens receiving the light beam radiated by the optical  
8 source so as to converge the light beam at micro-spots on the first and second substrates  
9 of the optical disk and including first and second regions passing the light beam so that a  
10 numerical aperture changer satisfies the relationship  $NA2 < NA1$ , in which NA2 is a  
11 numeral aperture of the second region to make the light beam converge onto the second  
12 optical disk and NA1 is a numeral aperture of a region comprising the first region and the  
13 second region to make the light beam converge onto the first optical disk;

14                (iii): focus control means for controlling focuses of the optical head apparatus  
15 correspondingly to the thicknesses of the substrates on the basis of the light beam, the  
16 focuses being realized by the convergence of the light beam passing the first and second  
17 regions of the compound objective lens;

18                (iv): tracking control means for performing a tracking control of the optical head  
19 apparatus correspondingly to the thicknesses of the substrates on the basis of the light  
20 beam; and

21                (v): information detecting means for determining whether each of the substrates is  
22 of thickness T1 or T2 and detecting pieces of information recorded on each determined  
23 substrate on the basis of the light beam;

24        (b): moving means for moving the optical head apparatus;

25        (c): rotating means for rotating the optical disk; and

26        (d): reproducing means for reproducing the pieces of information detected by the  
27 information detecting means upon a move of the optical head apparatus caused by the moving  
28 means and a rotation of the optical disk caused by the rotating means.

1       146 (New). An optical disk information equipment including the compound objective  
2 lens according to any one of claims 133-136, comprising:

3       (1) an optical disk apparatus, including:

4       (a): an optical head apparatus placed to face an optical disk including a first transparent  
5 substrate of thickness T1 and a second transparent substrate of thickness T2, the optical head  
6 apparatus comprising:

7           (i): an optical source for radiating a light beam;

8           (ii): the compound objective lens receiving the light beam radiated by the optical  
9 source so as to converge the light beam at micro-spots on the first and second substrates  
10 of the optical disk, the compound objective lens including first and second regions  
11 passing the light beam so that a numerical aperture changer satisfies the relationship  
12  $NA2 < NA1$ , in which NA2 is a numeral aperture of the second region to make the light  
13 beam converge onto the second optical disk and NA1 is a numeral aperture of a region  
14 comprising the first region and the second region to make the light beam converge onto  
15 the first optical disk;

16           (iii): focus control means for controlling focuses of the optical head apparatus  
17 correspondingly to the thicknesses of the substrates on the basis of the light beam, the  
18 focuses being realized by the convergence of the light beam passing the first and second  
19 regions of the compound objective lens;

20           (iv): tracking control means for performing a tracking control of the optical head  
21 apparatus correspondingly to the thicknesses of the substrates on the basis of the light  
22 beam; and

23           (v): information detecting means for determining whether each of the substrates is  
24 of thickness T1 or T2 and detecting pieces of information recorded on each determined  
25 substrate on the basis of the light beam;

26       (b): moving means for moving the optical head apparatus;

27       (c): rotating means for rotating the optical disk; and

28       (d): reproducing means for reproducing the pieces of information detected by the  
29 information detecting means upon a move of the optical head apparatus caused by the moving  
30 means and a rotation of the optical disk caused by the rotating means; and

(2): an image signal generator for generating an image signal based on the reproduced pieces of information.

147 (New). A computer system including the compound objective lens according to any one of claims 133-136, comprising:

(1) an optical disk apparatus, including:

(a): an optical head apparatus placed to face an optical disk including a first transparent substrate of thickness T1 and a second transparent substrate of thickness T2, the optical head apparatus comprising:

(i): an optical source for radiating a light beam;

(ii): the compound objective lens receiving the light beam radiated by the optical source so as to converge the light beam at micro-spots on the first and second substrates of the optical disk, the compound objective lens including first and second regions passing the light beam so that a numerical aperture changer satisfies the relationship  $NA2 < NA1$ , in which NA2 is a numeral aperture of the second region to make the light beam converge onto the second optical disk and NA1 is a numeral aperture of a region comprising the first region and the second region to make the light beam converge onto the first optical disk;

(iii): focus control means for controlling focuses of the optical head apparatus correspondingly to the thicknesses of the substrates on the basis of the light beam, the focuses being realized by the convergence of the light beam passing the first and second regions of the compound objective lens;

(iv): tracking control means for performing a tracking control of the optical head apparatus correspondingly to the thicknesses of the substrates on the basis of the light beam; and

(v): information detecting means for determining whether each of the substrates is of thickness T1 or T2 and detecting pieces of information recorded on each determined substrate on the basis of the light beam;

(b): moving means for moving the optical head apparatus;

(c): rotating means for rotating the optical disk; and

28            (d): reproducing means for reproducing the pieces of information detected by the  
29            information detecting means upon a move of the optical head apparatus caused by the moving  
30            means and a rotation of the optical disk caused by the rotating means;

31            (2): a signal inputting unit for inputting pieces of information to be recorded on the  
32            substrates;

33            (3): a central processing unit for processing the pieces of information recorded on the  
34            substrates and processing the pieces of information to be recorded on the substrates; and

35            (4): a signal outputting unit for outputting the pieces of information recorded on the  
36            substrates.